The Network of Robotic Echelle Spectrographs (NRES)
Las Cumbres Observatory (LCO)

Andrew Ridden-Harper[1,*], Curtis McCully[1], Rachel Street[1],
Prerana Kottapalli[1], & Daniel Harbeck[1] on behalf of the NRES team
*ariddenharper@lco.global, [1] Las Cumbres Observatory, 6740 Cortona Drive, Suite 102, Goleta, CA 93117, USA

Overview

- Designed for moderate RV precision for Vmag < 10
- Four identical robotic spectrographs
- Located in both hemispheres at four sites (see Fig. 1)
- Fed by 1x or 2x 1m telescopes depending on the site

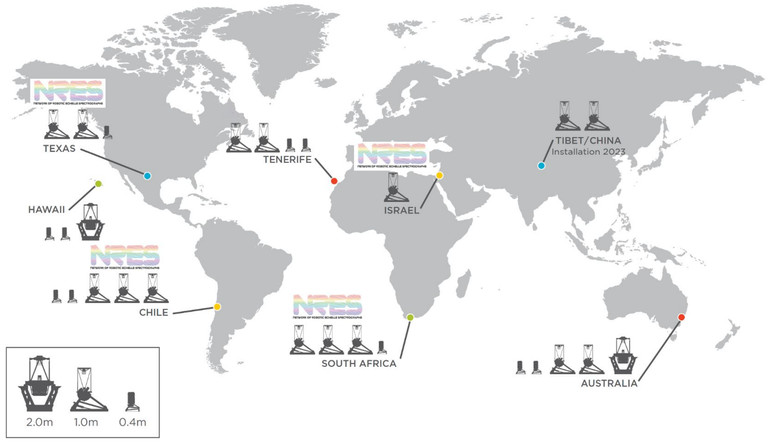

Fig 1: Locations of NRES units and other LCO sites (McCully et al. 2022).

Key characteristics of NRES

Resolving power	53k
Spectral range	380 - 860 nm
RV precision (at Vmag ~ 5.5)	Current: 20 m/s Goal: 3 m/s

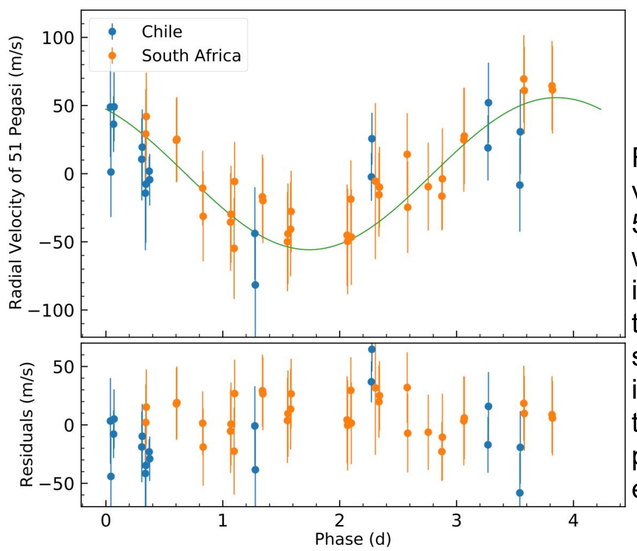

Fig. 2: Radial velocity curve of 51 Pegasi taken with NRES instruments at two different sites. The data is phase folded to the orbital period (McCully et al. 2022).

BANZAI-NRES

NRES data reduction pipeline

- Open source, Python based
- Automatically reduces NRES data within 90 seconds
- Provided data products:
  - Wavelength calibrated 1D spectrum
  - Measured stellar parameters
  - Measured radial velocity

Fig. 3: QR code linking to GitHub repository.

Working towards RV precision goal

- Optimizing line list used for wavelength calibration (e.g., Murphy et al. 2007)
- 2D wavelength solution and extraction to correct for astigmatism away from the chip center (Fig. 4)
- Use of simultaneous calibration fiber arc lamps to track fiber positions over the night
- Improved background subtraction

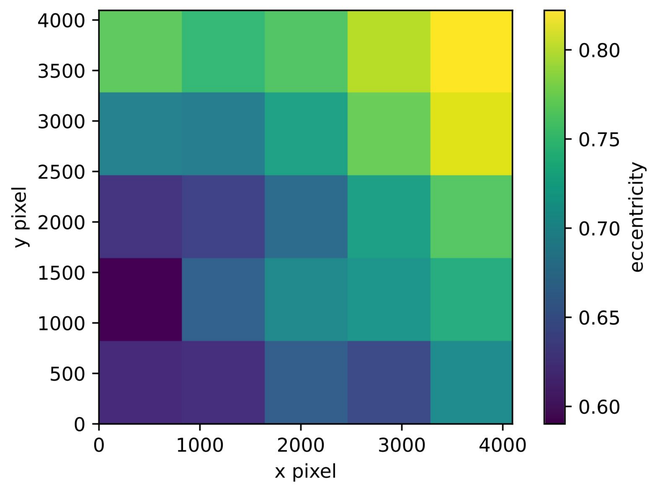

Fig. 4: Average regional eccentricity of ThAr emission lamp features over the CCD. The trend is likely due to astigmatism.

Supporting high-precision RV instrumentation

- NRES' moderate RV precision and global coverage make it ideal for reconnaissance
  - Sites in Northern and Southern hemispheres
  - Observations at any time of day
  - Identify the best targets for high-precision RV observations
  - Reserve time on high-precision instrumentation for the most promising candidates

- NRES supports TESS follow up campaigns
  - LCO Key Program (PI: Avi Shporer)
  - RV reconnaissance
  - Host star characterization

- Applying the BANZAI-NRES pipeline to high-precision RV instrumentation
  - Open source, Python based, modular design makes porting relatively straightforward
  - 1 m/s precision achieved on HARPS data (Brandt et al. 2020)
  - Allow comparisons of different processing techniques & pipelines

- New RV instruments can adapt BANZAI-NRES to decrease their own pipeline development costs

Further reading and references

Brandt, G. M., Brandt, T. D., McCully, C., 2020, AJ, 160:25
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Murphy, M. T., Tzanavaris, P., Webb, J. K., & Lovis, C. 2007, MNRAS, 378, 221
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